MANUALLY MANIPULABLE ACTUATOR MECHANISM HAVING CONSTRAINED RANGE OF MOTION

CROSS-REFERENCE TO RELATED PATENT

The present application is related to U.S. Patent No. 6,199,726, which is incorporated herein by reference in its entirety as background material.

BACKGROUND OF THE INVENTION

1. Technical Field:

[0001] The present invention relates in general to actuator mechanisms, and in particular, to manually manipulable actuator mechanisms having a constrained range of motion.

2. Description of the Related Art:

[0002] Manually manipulable actuator mechanisms are commonly employed to actuate or facilitate the operation or function of electronic, electro-mechanical and mechanical systems. These manually manipulable actuator mechanisms include a wide variety of push buttons, switches, dials, sliders, knobs, triggers and other actuator mechanisms.

[0003] A primary consideration in the design of an actuator mechanism is the range of motion through which the actuator mechanism will be permitted to move when subjected to anticipated levels of manual force. The range of motion through which an actuator mechanism moves can influence consumer perception of the overall system because too much "play" in the actuator mechanism is often taken as an indication of poor system design and/or quality. Moreover, the failure to properly constrain the range of motion of the actuator mechanism can lead to breakage of the actuator mechanism or improper operation of the system, for example, if the actuator mechanism is subject to greater than necessary force or force in a direction other than that

required to actuate the system.

SUMMARY OF THE INVENTION

[0004] In view of the foregoing, the present invention provides an actuator mechanism for electrical, electro-mechanical and mechanical systems that provides improved control of the range of motion through which the actuator mechanism is permitted to move.

[0005] In one embodiment of the present invention, a manually manipulable actuator mechanism includes a body and a manually manipulable element. The body has at least one wall element having a length extending along a first axis and a height extending along a second axis orthogonal to the first axis. The manually manipulable element has a button portion adapted for human digital manipulation and at least one wing portion extending outwardly from the button portion. The manually manipulable element is movable along the first axis between a first position in which an operative element is in a non-actuated condition and a second position in which the operative element is in an actuated condition. The wall element, which has a first height at the first position and a different second height at the second position, cooperates with the wing portion to constrain movement of the manually manipulable element at least along a third axis orthogonal to the first and second axes while the manually manipulable element is moved between the first and second positions.

[0006] All objects, features, and advantages of the present invention will become apparent in the following detailed written description.

BRIEF DESCRIPTION OF THE DRAWINGS

[0007] The novel features believed characteristic of the invention are set forth in the appended claims. However, the invention, as well as a preferred mode of use, will best be understood by reference to the following detailed description of an illustrative embodiment when read in conjunction with the accompanying drawings, wherein:

[0008] **Figures 1A** and **1B** illustrate an exemplary actuator mechanism in accordance with the present invention in non-actuated and actuated positions, respectively;

[0009] **Figures 2A, 2B** and **2C** respectively depict side, section and bottom views of an exemplary manually manipulable element in accordance with the present invention;

[0010] **Figure 3** illustrates the mating of the manually manipulable element of **Figures 2A-2C** with a spring in accordance with one embodiment of the present invention;

[0011] **Figure 4A** depicts a top view of an aerosol dispensing system in which the actuator mechanism of the present invention may advantageously be incorporated;

[0012] **Figures 4B** and **4C** are section views illustrating the actuator mechanism of **Figure 4A** in non-actuated and actuated positions, respectively;

[0013] **Figures 5A** and **5B** depict an exemplary actuator mechanism for an electrical system in non-actuated and actuated positions, respectively; and

[0014] **Figure 5C** is a side view of a manually manipulable element having electrical contacts in accordance with one embodiment of the present invention.

DETAILED DESCRIPTION OF ILLUSTRATIVE EMBODIMENT

[0015] With reference now to the figures, and in particular with reference to **Figures 1A-1B,** two views of a system **10** having an exemplary actuator mechanism in accordance with the present invention are shown. **Figure 1A** depicts system **10** with the actuator mechanism in a first, non-actuated position, and **Figure 1B** depicts system **10** with the actuator mechanism in a second, actuated position.

[0016] The actuator mechanism includes at least a manually manipulable element **12** and a means for constraining the range of motion of manually manipulable element **12**. In the depicted embodiment, the means for constraining the range of motion of manually manipulable element **12** includes at least one and in this case, two wall portions **20** of a body **18** within system **10**. Wall portions **20**, which are generally parallel, have a length generally extending along a first axis **30** and a height generally extending along an orthogonal second axis **32**. Wall portions **20** may be integrally formed with body **18** (e.g., by molding) or may be joined to or mounted on body **18** by other conventional techniques selected based upon the materials employed.

[0017] Although not required by the present invention, the height of wall portions **20** may vary along first axis **30**, for example, by increasing or decreasing as manually manipulable element **12** is moved from the first position illustrated in **Figure 1A** and the second position shown in **Figure 1B**. In the depicted embodiment, wall portions **20** comprise a first extent **22** having a substantially uniform greater height, a second extent **24** having a substantially uniform lesser height, and a steeply sloping intermediate extent **26**.

[0018] As shown in **Figures 1A-1B** and as illustrated in greater detail in **Figures 2A-2C**, manually manipulable element **12** includes a button portion **14** and one or more (and this case two) wing portions **16** extending outwardly from button portion **14**. Button portion **14**, which may have a wide variety of shapes including the mounded form shown in **Figure 2A**, is preferably sized for comfortable human digital manipulation and may have a profile or texture on at least one surface, such as that provided by integral ridges **40**, to enhance frictional contact

with a user's digit for ease of manipulation. Wing portions **16** are preferably integrally formed with button portion **14** and are sized and configured to cooperate with the one or more wall portions **20** to constrain the range of motion of manually manipulable element **12**.

[0019] For example, in the depicted embodiment, wing portions **16** are generally L-shaped and include a horizontal leg **42** and a vertical leg **44**, which are sized to span wall portions **20** such that horizontal legs **42** (and manually manipulable element **12**) are supported by the upper surface of wall portions **20**. Thus, wing portions **16** constrain the range of motion of manually manipulable element **12** along second axis **32** in accordance with the respective heights of wall portions **20** at each position along first axis **30**. Vertical legs **44** of manually manipulable element **12** further constrain the range of motion of manually manipulable element **12** along second axis **34** by engaging at least one of wall portions **20** and/or an interior surface of body **18** when a maximum extent of motion is reached.

[0020] Wing portions **16** may further constrain the range of motion of manually manipulable element **12** along first axis **30** when manually manipulable element **12** is in the second position shown in **Figure 1B**. In particular, wing portions **16** may be sized and configured so that the leading edges of wing portions **16** engage respective stops **50** when a maximum extent of translation in a first direction along first axis **30** is reached. And because the height of second extent **24** is substantially less than that of first extent **22**, when manually manipulable element **12** is at the second position, the trailing edge of manually manipulable element **12** engages intermediate extent **26** (or alternatively a second stop disposed between wall portions **20** and body **18**) to constrain translational movement of manually manipulable element **12** in a second direction along first axis **30**. At the second position, rotation of manually manipulable element **12** about third axis **34** is also constrained by the engagement of the leading edges of vertical legs **44** with stops **50** and the trailing edges of horizontal legs **42** with intermediate extents **26**.

[0021] It will be appreciated that in alternative embodiments, wing portions **16** may be sized and configured to cooperate with wall portions **20** and body **18** in manner different from that depicted in **Figures 1A-1B**. For example, wing portions **16** may be configured so that the

bottom edges of vertical legs **44** support manually manipulable element **12**. Additionally or alternatively, one or more of wing portions **20** may cooperate with the interior rather than the exterior surfaces of wall portions **20** to constrain the range of motion along third axis **34**.

[0022] Depending upon the selected application, it may be desirable or even required for manually manipulable element **12** to be coupled to one or more additional elements to facilitate the actuation of system **10**. As shown in **Figure 2C** as well as **Figure 2B**, which is a section view taken along line A—A of **Figure 2A**, coupling of manually manipulable element **12** to another element manually manipulable element **12** is facilitated by molding or tooling within button portion **14** an interior cavity **46** suitable for receiving an attachment tab of another element.

[0023] For example, interior cavity may receive an attachment tab of a slidable switch. Alternatively, as indicated in **Figure 3** with dashed lines, an attachment tab **82** of a spring **76** may be received within a corresponding slot in the interior cavity **46**, with an integral spring member **84** engaging an interior surface of manually manipulable element **12**. Manually manipulable element **12** may be retained on attachment tab **82**, for example, by interference fit, spring tension, or suitable epoxy. In the depicted embodiment, spring **76**, which may be identical to that disclosed in the above-referenced patent, is L-shaped and has a first leg **80** terminating in attachment tab **82** and a second leg **86** in which an opening **78** is formed.

[0024] **Figures 4A-4C** illustrate the use within an aerosol dispensing system **70** of an actuator mechanism as shown in **Figures 1A-1B** together with a spring **76** as shown in **Figure 3**. **Figures 4B-4C**, which are section views of aerosol dispensing system **70** taken along line B—B of **Figure 4A**, depict aerosol dispensing system **70** in non-actuated and actuated conditions, respectively.

[0025] In aerosol dispensing system **70**, body **18** includes or is coupled to a top housing **19** that, together with the remainder of body **18**, defines an interior volume that is sized to receive and enclose a pressurized canister **56** containing a substance to be dispensed. Pressurized canister **56**

includes a nozzle **62** that is substantially aligned, at least during dispensing of the substance **54**, with an aperture **52**. Canister **56** remains substantially stationary with respect to body **18**, with its forward travel (i.e., toward aperture **52**) constrained by molded stops such as a pair of posts **72** (only one of which can be seen in **Figure 1A**) that engage the shoulder **74** of canister **56**.

[0026] In top housing **19**, a slot **58** is formed through which button portion **14** of manually manipulable element **12** protrudes. As seen best in **Figures 4B-4C,** spring **76** is installed within top housing **19** with the terminating end of second leg **86** captured between one or more ramps **90** and a wall **92** integral to body **18**. Nozzle **62** of canister **76** passes through opening **78** in spring **76**. With this arrangement, spring **76** urges manually manipulable element **12** toward the first position depicted in **Figure 4B**.

[0027] When manually manipulable element **12** is in the first position depicted in **Figure 4B**, manually manipulable element **12** is constrained from substantial movement along second axis **32** by the first extent of wall elements **20** and top housing **19**. In addition, nozzle **62** remains in axial alignment with canister **56**. Accordingly, the toggle valve of canister **56** is closed, and the substance stored under pressure within canister **56** is not dispensed. As shown in **Figures 4A-4B**, with manually manipulable element **12** in first position, first leg **80** of spring **76** also advantageously blocks access to the interior of aerosol dispensing system **70** through slot **58**, thus preventing inadvertent dispensing of the substance in canister **56** due to an object contacting nozzle **62** through slot **58**.

[0028] In order to move manually manipulable element **12** from the first position shown in **Figure 4B** to the second position shown in **Figure 4C**, the user translates manually manipulable element **12** axially forward against the urging of spring **76**, preferably with the thumb of his or her hand. As manually manipulable element **12** is moved axially forward from the first position, substantial downward movement of manually manipulable element **12** along second axis **32** is prevented as long as wing portions **16** rest on first extent **20** of wall elements **20**. However, once wing portions **16** clear first extent **20** of wall portions **20**, manually manipulable element **12** may selectively be driven downward along second axis **32** against the urging of spring **76**. Second

extents **24** of wall portions **20** are sufficiently different in height from first extents **20** to permit one or both of manually manipulable element **12** and first leg **80** of spring **76** to engage enlarged diameter portion **64** of nozzle **62**. As shown in **Figure 4C**, nozzle **62** is thereby diverted from axial alignment with canister **56** against the combined spring force of spring **76** and the toggle valve spring, thus forcing the toggle valve open and dispensing substance **54** from canister **56** as a result of the pressure differential between the ambient environment and the interior of canister **56**. When the force applied to manually manipulable element **12** diminishes to less than the spring force of spring **76**, the urging of spring **76** automatically returns manually manipulable element **12** to the first position shown in **Figure 4B**, and the spring force of the toggle valve closes the toggle valve and returns nozzle **62** to axial alignment with canister **56**, as also shown in **Figure 4B**.

[0029] It should further be noted that slot **58** is preferably sized and configured to cooperate with wall portions **20** in constraining the range of motion of manually manipulable element **12**. For example, in a preferred embodiment, the anterior edge **59** of slot **58** is axially forward of the second position of manually manipulable element **12** shown in **Figure 4C** so that the translation of manually manipulable element **12** from the first position shown in **Figure 4C** to the second position is not impeded. However, anterior edge **59** engages the leading edge of button portion **14** to constrain manually manipulable element **12** if force is applied to rotate button portion **14** about third axis **34**. Posterior edge **60** of slot **58** similarly engages the trailing edge of button portion **14** to prevent excessive backward translation along first axis **30** and excessive rotation about third axis **34**. Side edges **61** of slot **58** further cooperate with wall portions **20** to constrain the translation of button portion **14** along third axis **34** and rotation of button portion **14** about first axis **30**. By constraining manually manipulable element **12** in this way, spring **76** is protected against deformation and breakage, and detachment of manually manipulable element **12** from attachment tab **82** is prevented. Moreover, constraining manually manipulable element **12** in this manner imparts a "solid" tactile impression, which to most users connotes quality, thoughtful design, and reliability.

[0030] Referring now to **Figures 5A-5B**, there are depicted two views of an exemplary actuator

mechanism for an electrical system **100** in non-actuated and actuated conditions, respectively. As can be seen by comparison of **Figures 5A-5B** to **Figures 1A-1B**, system **100** depicted in **Figures 5A-5B** is substantially similar to system **10** described above, except for the inclusion of an electrical circuit **102** and electrically conductive elements to facilitate the actuation of electrical circuit **102**.

[0031] As shown in **Figure 5A**, electrical circuit **102** is electrically coupled to electrically conductive contacts **104** formed on or in wall portions **20** and/or the hidden surfaces of stops **50**. With this arrangement, electrical circuit **102**, which may be a power circuit, is in a non-actuated condition in **Figure 5A** due to the open circuit that exists between electrical contacts **104**.

[0032] To permit electrical connection between electrically conductive contacts **104**, manually manipulable element **14'** includes two or more electrically conductive contacts **106** at locations corresponding those of electrically conductive contacts **104**, as illustrated in **Figure 5C**. Electrically conductive contacts **106** are electrically connected by an electrical conductor **96**. With this arrangement, a user actuates electrical circuit **102** (and/or the larger system **100**) by moving manually manipulable element **14'** to the second position depicted in **Figure 5B**, thereby completing a conductive loop through corresponding contacts **104, 106** and conductor **108**.

[0033] It should be understood upon reference to the foregoing that wall portions **20** in **Figures 5A-5B** may have different profiles than that illustrated and that system **100** may or may not include a spring element (such as spring **76**), depending upon the intended application of system **100**. System **100** may further include a top housing (such as top housing **19**) to further constrain the range of motion of the actuator mechanism.

[0034] As has been described, the present invention provides an improved manually manipulable actuator apparatus for a mechanical, electro-mechanical or electrical system. The actuator apparatus includes a manually manipulable element having wings that cooperate with one or more wall elements to constrain the range of motion of manually manipulable element. The improved translation and rotational constraint provided by the present invention reduces the

likelihood of system damage and/or failure and improves user perception of the quality, design and reliability of the overall system.

[0035] While the invention has been particularly shown as described with reference to a preferred embodiment, it will be understood by those skilled in the art that various changes in form and detail may be made therein without departing from the spirit and scope of the invention.